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COMPARISON BETWEEN BONE SUPPORTED-PENDULUM APPLIANCE AND LEVER-ARM MINI-IMPLANT SYSTEM IN MAXILLARY MOLAR DISTALIZATION IN CLASS II MALOCCLUSION

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ABSTRACT

Upper molar distalization with noncompliance therapies has become more popular in treatment of Class II malocclusions.

Purpose: This study was conducted to evaluate and compare the dentofacial changes after distalization of maxillary first molars using bone anchorage pendulum and Lever-arm mini-implant system in the treatment of dental Class II cases non-extraction cases.

Subjects and Methods: The sample of this study was consisted of 30 patients of both sexes (16- 22 years old) divided into two groups. The first group consisted of 15 patients, their molar were distalized with BAPA. The second group consisted of 15 patients, their molar were distalized with LAMS. The evaluation of the study was performed by detecting the changes on dental casts and lateral cephalograms.

Results: All maxillary molars were distally moved into a super class I relationship successfully in both groups (7.2 months in BAPA group and 10.5 months in LAMS group) and there was a highly significant changes in the distal tipping of the maxillary first molar between the two groups, BAPA (22.8°) while the amount of distal tipping of the maxillary first molar in LAMS group was (10.29°).

Conclusion: Both LAMS and BAPA appliances were effective, less invasive and compliance free alternative for intraoral upper molar distalization without anchorage loss. Lever-arm and mini-implant system was effective for achieving absolute anchorage during the distal movement of upper molars.

KEY WORDS: Molar distalization, bodily distalization, classII malocclusion, bone anchorage pendulum appliances, lever-arm mini-implant system.

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INTRODUCTION

Distalization of maxillary molar is considered a frequently used orthodontic treatment modality for the treatment of a Class II molar relation and/or space creation. Several devices including headgear, Jones jigs, distal jets, and pendulums were used for upper molar distalization.[1]

Upper molars can be distally moved by many designs either extraoral or intraoral. Extraoral traction methods such as headgear is most commonly produce orthopedic and orthodontic changes. The major drawback of an extraoral method is the decrease of patient compliance during treatment.[2] Distalization of upper molar is rarely taken into consideration, as it is difficult to distalize the upper molars after the eruption of the upper second and third molars, also mandibular growth cannot be expected.[3]

Recently, orthodontic bone supported maxillary molar distalizers using skeletal anchorage are the standard treatment modality. They are not restricted by compliance of the patient and they can decrease the anchorage loss. There are varieties of skeletal anchorage options available to distalize maxillary molars. Most of these treatment techniques lead to variable dental effects, with different levels of benefits for both the operators and the patients.

Orthodontists have to understand the effects of each appliance before the treatment selection.[4]

A treatment system using midpalatal miniscrews was reported by Lim et al[5] that described the use of the lever-arm and mini-implant system to control the distalizatio of upper molars. Within the proposed treatment modalities, upper molar distalization can be achieved by two different design of appliances, bone supported pendulum and lever-arm mini-implant distalization systems.

AIM OF THE WORK

This study was designed to evaluate and compare the dentofacial changes after distalization of maxillary first molars using bone anchorage pendulum and Lever-arm mini-implant appliances in the treatment of dental Class II cases (non-extraction cases).

SUBJECTS AND METHODS

The sample of this study comprised of 30 randomly selected subjects from patients seeking orthodontic treatment in Orthodontic Department, Faculty of Dentistry, Tanta University.

Approval for this research was obtained from Research Ethics Committee, Faculty of Dentistry, Tanta University. The purpose of the present study was previously explained and informed consents were obtained from the patients according to the guidelines on human research adopted by the Research Ethics Committee, Faculty of Dentistry, Tanta University.

The patients were selected according to the following criteria:

The patient's age ranged from 16 to 22 years at the start of the treatment, good oral hygiene, none of the patients had received any orthodontic treatment, permanent dentition (patients with retained deciduous teeth will be excluded). The patients should have Class II molar relationship and Class I skeletal relationship with an acceptable soft tissue facial profile. There is minimal or no crowding in the mandibular arch with non-extraction treatment plan with molar distalization.

The patients were divided into two groups: group 1 consisted of 15 patients, their upper molars were distalized with bone anchorage pendulum appliances (BAPA) and group 2 consisted of 15 patients, their upper molars were distalized by the lever-arm with mini-implant system (LAMS). All the patients were clinically examined and the following records were taken before and after distalization as well, extra-oral and intraoral photographs, panoramic x- ray film, lateral cephalometric radiographs and study models. Figure 1 represented BAPA group before and after distalization, while figure 2 represented LAMS group before and after distalization.

Fig. (1) BAPA group before and after distalization.

Fig. (2) LAMS group before and after distalization.

Construction of BAPA:

The bone anchorage pendulum appliances composed of the pendulum appliance constructed following Hilgers chriteria.[6] Two titanium mini-implants* (1.8 mm diameter and 8 mm length) were used as rigid bone anchors. The mini-implant insertion was performed with the patient under local anesthesia. They were placed in the anterior paramedian region of the median palatal suture using 3M contra angle screw driver** with the specific mini-implant adaptor.*** After soft tissue healing, stone casts were poured from alginate impressions having the mini-implants and upper molar bands in place. The pendulum springs were made of 0.032» Titanium-Molybdenum-Alloy wire (TMA). The springs were performed to include a closed helix loop which had two arms one was short which represented the retentive arm and the other was long which represented the active or distalizing arm. The short arm of the pendulum spring was

* MCT Mini-implant (Mr. Curette Tech) Sangdaewon-dong Korea.
** 3M Unitek™ St. Paul, MN55144-1000 USA Temporary Anchorage Device Contra Angle Screw Driver.
*** MCT Mini-implant adaptor.

shaped into a retentive loop. The other long arm of the spring was formed into a vertical loop which was adjusted so its distalizing terminal end was bent at a right angle to engage the 0.036» lingual sheath on the lingual surface of the first permanent molar band. This bend was parallel to the tube of the lingual sheath in the vertical and sagittal plane. The two pendulum springs for the right and left side were positioned in the palate close to the median raphe as possible to allow a wide range of action giving flexibility to the spring for easy insertion into the lingual sheath. Nance acrylic button was fabricated on the stone model. The Nance button with the activated pendulum springs were checked for adaptation on the palatal screws, then the mini-implant's head was connected to the acrylic plate, using chemical curing composite resin. Before inserting the appliance in the mouth, the pendulum springs were activated extraorally on the model. The activation of the appliance was done by bending the springs a 90° angle resulting in 300 grams of distalizing force. Reactivation and Follow up was performed every 3 weeks. After distalization (super Class I molar relation), the springs terminal ends of were deactivated to allow the lingual sheaths to fit passively.

Construction of LAMS :

The first maxillary molars were banded and the upper second molars were bonded with a 0.022-inch tube. Trans palatal arch (TPA) was used as a palatal lever arm, while the buccal lever arm was performed according to Lim et al[5] from stainless steel wire (0.019X0.025 inch), with a stopper mesial to first molar tube and anteriorly it has an omega loop adjacent to the upper canine in order to attach the elastic chain. The buccal mini-implants was manually inserted with a screwdriver at the mucogingival line between upper second premolar and first molar. On the other hand the palatal mini implant was located in the median palatine suture adjacent to the maxillary first molar. The three mini-implants were used with length of 8mm and diameter of 1.8mm.

The two buccal ones were inserted using the straight screw driver and the palatal one was inserted with the contra angle screw driver so that the screw tip faced anteriorly and the screw head faced posteriorly. The maxillary and mandibular casts were mounted on simple hinge articulator with wax bite taken in the centric occlusion. Then the following measurements[7] were made on the upper arch cast using Boly gauge graduated to the nearest 0.1 mm: maxillary arch perimeter, maxillary intercanine width, maxillary intermolar width, overjet and overbite.

Standard lateral cephalometric radiographs were recorded with the patient's closed-mouth before and after treatment. Each cephalogram was traced and analyzed by the same operator.

Skeletal measurements including:[8,9]

1- SNA, SNB, ANB and Frankfort mandibular plane angles.

2- Total anterior facial height (N-Me), Posterior facial height (S-Go) and Lower anterior facial height (ANS-Me).

3- SNA, SNB, ANB, FMA, N-Me, ANS-Me and S-Go.

Dental measurements: The Frankfort horizontal plane and the pterygoid vertical plane were used to measure the cephalometric dental changes.[10]

Dental linear measurements including: U6- PTV, U5- PTV, U4- PTV, U1-PTV, U6- FH, U5- FH, U4- FH and U1- FH. Dental angular measurements including: U6- FH, U5- FH, U4- FH and U1- FH.

Statistical analysis: All data and measurements presented in this study were subjected to statistical evaluation using the mean ± standard deviation and t test by SPSS V (16). A $p \leq 0.05$ is considered statistically significant where $p \leq 0.001$ is considered statistically highly significant.

RESULTS

The means, standard deviations and the significance of the treatment changes of all measurements of the two tested groups were represented in tables from 1 to 5. Comparing the data of the dental casts between the two studied groups revealed a non-significant difference in the maxillary arch perimeter, intermolar, intercanine widths, overjet and overbite (p>0.05) (Table 1). As illustrated in table (2), there was no significant difference of the linear or angular skeletal measurements in the horizontal and vertical relationships (SNA, SNB, ANB, FMA, N-Me, ANS-Me and S-Go) between the two studied groups (p>0.05). The horizontal and vertical position of the maxillary first molars, second premolars, first premolars and central incisors showed insignificant differences between the two studied groups (p>0.05) (Table3). In table (4), the angular measurements in relation to Frankfort horizontal plane, the maxillary first molars shows a highly significant difference between the studied groups (P< 0.001). These teeth showed more distal tipping in BAPA group, whereas they showed less distal tipping in lever-arm and mini-implant system group (more bodily distslization). The distalization time was significantly long in lever-arm and mini-implant system group by 3.3 months (P< 0.05) when compared with BAPA group (Table 5).

TABLE (1): Comparison of the dental cast analysis between (group I) and (group II).

Dental cast analysis		N	Mean	Std. Deviation	t	p-value
Maxillaryarch perimeter (mm)	GI	15	16.1	0.57	1.391	0.178
	GII	15	12.9	0.55		
Maxillary intercaninewidth (mm)	GI	15	1.1	0.12	0.186	0.854
	GII	15	0.9	0.15		
Maxillary intermolar width (mm)	GI	15	3.3	0.27	-1.840	0.079
	GII	15	5.4	0.27		
Overjet (mm)	GI	15	-0.25	0.50	0.537	0.596
	GII	15	-0.48	1.27		
Overbite (%)	GI	15	2	0.06	1.416	0.171
	GII	15	8	0.12		

TABLE (2): Comparison of the cephalometric skeletal measurements between (group I) and (group II).

Skeletal measurements		N	Mean	Std. Deviation	t	p-value
SNA angle (degree)	GI	15	0.25	0.86	1.600	0.124
	GII	15	-1.07	2.50		
SNB angle (degree)	GI	15	-0.35	1.16	0.813	0.425
	GII	15	-0.93	2.02		
ANB angle (degree)	GI	15	0.60	0.84	1.587	0.127
	GII	15	-0.14	1.29		
FMA angle (degree)	GI	15	0.50	1.58	-0.300	0.767
	GII	15	0.71	1.82		
Total anterior facial height (N –Me) (mm)	GI	15	0.12	0.40	-0.976	0.340
	GII	15	0.29	0.45		
Lower anterior facial height(ANS-Me) (mm)	GI	15	0.22	0.23	1.195	0.245
	GII	15	0.11	0.23		
Posterior facial height (S-Go) (mm)	GI	15	0.04	0.28	-0.958	0.348
	GII	15	0.16	0.31		

TABLE (3): Comparison of the cephalometric dental linear measurements between (group I) and (group II).

Dental linear measurements		N	Mean	Std. Deviation	t	p-value
U6- PTV (mm)	GI	15	-7.9	0.35	-0.521	0.607
	GII	15	-7.1	0.35		
U5- PTV (mm)	GI	15	-4.9	0.24	-0.878	0.390
	GII	15	-4.0	0.25		
U4- PTV (mm)	GI	15	-2.5	0.26	-0.294	0.771
	GII	15	-2.2	0.21		
U1- PTV (mm)	GI	15	0.0	0.23	0.184	0.856
	GII	15	-0.1	0.15		
U6- FH (mm)	GI	15	-1.5	0.23	0.590	0.561
	GII	15	-2.7	0.62		
U5- FH (mm)	GI	15	0.3	0.18	0.814	0.424
	GII	15	-1.5	0.68		
U4- FH (mm)	GI	15	0.7	0.16	0.688	0.499
	GII	15	-0.6	0.60		
U1- FH (mm)	GI	15	3.8	0.91	1.365	0.186
	GII	15	-0.4	0.61		

TABLE (4): Comparison of the cephalometric dental angular measurements between (group I) and (group II).

Dental angular measurements		N	Mean	Std. Deviation	t	p-value
U6- FH (degree)	GI	15	-22.80	7.45	-4.460	0.000**
	GII	15	-10.29	6.27		
U5- FH (degree)	GI	15	-14.55	3.52	-1.915	0.069
	GII	15	-9.50	7.75		
U4- FH (degree)	GI	15	-6.60	5.27	0.471	0.643
	GII	15	-7.71	6.01		
U1- FH (degree)	GI	15	-3.95	4.50	-1.168	0.255
	GII	15	-1.79	4.46		

Table (5): Comparison of the distalization time (in month) between (group I) and (group II).

		N	Mean	Std. Deviation	t	p-value
Distalization Time in Month	GI	15	7.2	2.43	2.433	0.021*
	GII	15	10.5	3.14		

DISCUSSION

Class II treatment is one of the most controversial issues in orthodontics, due to the extensive variability of treatment strategies considering the morphologic features of this malocclusion.

Noncompliance intramaxillary appliances, which derive its anchorage as an absolute anchorage manner, act only in the maxillary arch in order to achieve distalization of upper molars[11], e.g. the Pendulum Appliance,[12] the Distal Jet[13] Repelling magnets[14] the Jones Jig[15] and palatal implants.[16,17]

The purpose of this study was to evaluate and compare the dentofacial changes after distalization of maxillary first molars using bone anchorage pendulum and Lever-arm mini-implant appliances in distalization of maxillary molars in non-extraction Class II cases.

Mini-implants and length-reduced palatal implants are introduced as bone anchorage devices[18,19]. The used two titanium bone screws (2.0 mm diameter and 9 mm length) inserted with the straight screw driver was reported, [10,20] while in the present study, two titanium mini-implants (1.8 mm diameter and 8 mm length) as a rigid bone anchors in BAPA design. The mini screw was inserted in the paramedian region due to its higher bone density and resistance and the optimal areas are those at 3 mm from the median suture and 8 mm from the incisive foramen.[21] As the placement and removal of the screws was considered a simple procedure in comparison to conventional orthodontic implants, miniplates and onplants, so they were used as temporary anchorage in both study groups.[22]

In LAMS group, 3 mini-implants (1.8 mm diameter and 8 mm length of each) were used. Two of them were placed buccally between the maxillary first molar and the second premolar. The third one is placed in the midpalatal suture adjacent to the first molars. The midpalatal area is an excellent position for insertion of the miniscrews in the maxilla due to its hard and soft tissue characteristics.[23,24,25]

Maxillary molar distalization continued till achieving super Class I molar relation. Over correction of upper molars is recommended to avoid anchorage loss that may occur during the retraction of incisors, canines and premolars.[26]

The duration of distalization in the BAPA group (7.2 months) was in agreement with the results of Önçag˘ et al[27] who utelized osseointegrated implant supported pendulum, and Kircelli et al [10] and Ozsoy et al[28] who used bone anchorage pendulum appliance; however, Escobar et al [20] explained a longer distalization periods (7.8 months) when using a bone-supported pendulum. This could be explained by the difference in the appliances and the distalizing mechanics. Also, difference in the distalizing force could play a role.

There was a highly significant increase in the upper arch perimeter in both groups, 16.1 mm in BAPA group within 7.2 months and 12.9 mm in LAMS group within 10.56 months and the difference between the two groups was not significant in amount but significant in time.

The maxillary intermolar width was significantly increased in both groups, which was slightly greater in LAMS group (5.4mm) than in BAPA group (3.4mm). The increase in the intermolar width was related to the distalization of the first molar through the wide area of the dental arch. The result in BAPA were in agreement with those of Kircelli et al [10](3.0 ± 3.0mm) and was the adverse of Escobar et al [20] who stated that the bimolar width did not show significant differences, while the result in LAMS were in twice with those of Lim et al.[29] and Sadek et al[30] (2.57 mm). The upper intercanine widths showed a significant increase in both groups. This increase may be attributed to distal movement of the maxillary anterior teeth into a wide area of the dental arch. This increase in intercanine widths was in agreement with Sadek et al.[30]

The results of the present study revealed that, there was no effect on the antero-posterior position of the maxilla and the mandible (SNA, SNB) in the two groups. These skeletal findings confirming the previous findings of many studies.[31,32,10,33,28] who stated that BAPA had no significant effect on sagittal skeletal measurements.

Slight nonsignificant increase was detected in the mandibular plane angle in both groups (0.50^{o} in BAPA and 0.71^{o} in LAMS group) and at the end of distalization, whereas the overbite was decreased insignificantly in both groups. That was in agreement with Kircelli et al[10], Escobar et al[20]and Polat-Ozsoy et al. [28] This degree of clockwise rotation of the mandible can be related to the distal movement of upper molars into the wedge of occlusion and to the cuspal interdigitation. Also, there was a significant increase in the lower anterior facial height (ANS-Me) in BAPA and total anterior facial height (N-Me) in LAMS. This was similar to the increase reported by other studies[34,35,36,10,37] who stated that facial form, lower anterior facial height increased by 2.8mm, the mandibular plane angle increased by 1.3°, and overbite decreased by 1.8mm during 6.5 months of treatment. However, the difference between the two groups was not significant.

The upper incisors were retroclined by 3.95° and distally moved by 0.38 mm in the BAPA group and retroclined by 1.79° and 0.4 mm in the LAMS group. This is in accordance with two previous studies.[20,27] This amount of upper incisor retroclination was seen in the bone-anchored group, might be due to the distal movement of the first and second premolars. This movement was favorable and positively shortened the treatment time. In addition, in LAMS group findings of the present study matched that of Sadek et al[30] who stated that the inclination of the upper incisors was changed to be within the normal range and retracted by 3.15mm.

One of the most characteristic aspects of both appliances was the spontaneous distal movement of premolars with molars. There is no need to do much retraction for anterior teeth.[38] Moreover, anterior crowding has been simultaneously corrected due to the stretched transeptal fibers. As a consequence, the total treatment time was decreased.

CONCLUSION

From the previous results, it was revealed that both appliances were effective, minimally invasive and compliance free alternatives for intraoral molar distalization without anchorage loss. The LAMS was advantageous not only for absolute anchorage, but also for control of distal movement of upper molars in the three-dimensions.

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